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El-Sayed Abou-Zeid

Concordia University, sayed@jmsb.concordia.ca

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A META-METHODOLOGY FOR KNOWLEDGE MANAGEMENT SUPPORT SYSTEMS DEVELOPMENT

El-Sayed Abou-Zeid
Department of Decision Sciences and MIS
John Molson School of Business
Concordia University
1455, de Maisonneuve Blvd. W.
Montreal, Canada, H3G 1M8

Email: el-sayed@jmsb.concordia.ca

Abstract

The salient features of organizational knowledge and its manipulating activities make it difficult for traditional systems development methodologies to be directly applicable. Therefore, there is a need for a new generation of knowledge management support systems (KMSS) development methodologies that take into consideration such features. By extending the “information system design theory” of Walls et al this paper proposes a “design theory” for constructing development methodology for knowledge management support systems. The proposed design theory addresses the two aspects of design, namely, the product (methodology) and the process (meta-methodology). It also includes the existing features of KMSSs and theories from the natural and social sciences that used to inform their development methodology description and construction process. The theory of autopoiesis, as a system-grounded way of thinking with biological foundations, is used to characterize the required features of KMSS development methodology, i.e., methodology meta-requirements.

Keywords: Design Theory, Knowledge Management Support Systems, Development Methodology, Autopoiesis

1. INTRODUCTION

As the awareness of the importance of managing organizational knowledge grows, the issue of how to build information and communication technology (ICT)-based systems to support knowledge management activities has been raised. However, as argued by Malhotra (2002), the underlying premises guiding the development of ICT-based knowledge management support systems (KMSS) increase the possibility of their failure. Moreover, the salient features of organizational knowledge makes it difficult for traditional systems development methodologies to be directly applicable. Therefore, there is a need for a new generation of development methodologies that take into consideration the distinctive features of organizational knowledge and its manipulating activities. One possible approach for constructing such methodologies is to develop a “methodology design theory” similar to the “information system design theory (ISDT)” developed by Walls et al. (1992). According to them such design theory must have two aspects: one is dealing with the system (design product) and the other is dealing with the procedures of designing the system (design process). In addition, these two aspects have to be grounded on theories from natural or social sciences, i.e., kernel theories.

To this end the objective of this work is twofold. First is to develop a design theory for constructing development methodologies for KMSS. Second is to explore the potential of theory of autopoiesis as

one of the kernel theories for dealing with “product” aspects of “KMSS development methodologies” design theory.

The remainder of this paper is organized as follows. In section 2 the proposed design theory for KMSS development methodologies is presented. Section 3 discusses the distinctive features of organizational knowledge, knowledge management support systems and their development process. Then the autopoiesis theory, as a kernel theory, and autopoietic view of organizational knowledge are discussed in section 4. Implications of theory of autopoiesis for KMSS development methodology are discussed in section 5. The paper concludes by summarizing the findings.

2. A DESIGN THEORY FOR KMSS DEVELOPMENT METHODOLOGIES

A “information system design theory (ISDT)”, as explicated by Walls et al. (1992), must have two aspects - one dealing with the system (design product) and the other dealing with the procedures of designing the system (design process). They suggest that an IS design theory for an IS design product should consist of *meta-requirements* (the class of goals to which the theory applies), *meta-design* (the class of artifacts hypothesized to meet the meta-requirements), *kernel theories* (theories from the natural and social sciences governing design), and *testable design product hypotheses* (used to test whether the meta-design satisfies the meta-requirements). On the other hand, the IS design process would comprise a *design method* (a description of the procedures for artifact construction), *kernel theories* and *testable design process hypotheses* (used to verify whether the design method results in an artifact which is consistent with the meta-design).

As argued by Iivari (2003) and Venable (2006) a design method and/or information system development (ISD) methodology can be considered as an IS artifact that can be designed. The design for a design method and/or ISD methodology is itself a meta-design/meta-methodology in that it will always be instantiated differently in each instance of its application. In this context an *ISD methodology* is defined as "an organized collection of concepts, methods (or techniques), beliefs, values, and normative principles supported by material resources" (Hirschheim et al., 1996). On the other hand ISD method is defined as "a codified set of goal-oriented 'procedures' which are intended to guide the work and cooperation of the various parties (stakeholders) involved in the building of an information systems application. (Iivari et al., 1998).

Extending Walls et al. IS design theory to the realm of development methodologies requires redefinition of its main constituents. The first constituent of “KMSS development methodologies design theory”, *methodology meta-requirements* (meta-requirements), is defined as the class of goals, concepts, beliefs, values, and normative principles to which the theory applies. The second constituent, *methods* (meta-design), is defined as the class of methods hypothesized to meet the methodology meta-requirements. The third constituent, *meta-methodology* (design method), is defined as a description of the procedures for methodology construction. The fourth constituent is *testable hypotheses* that used to test whether the hypothesized method satisfies the methodology meta-requirements. The fifth constituent is the existing features of KMSSs. Finally *kernel theories* which include theories from the natural and social sciences that used to inform their development methodology description and construction process. Figure (1) depicts these elements and the relationships between them.

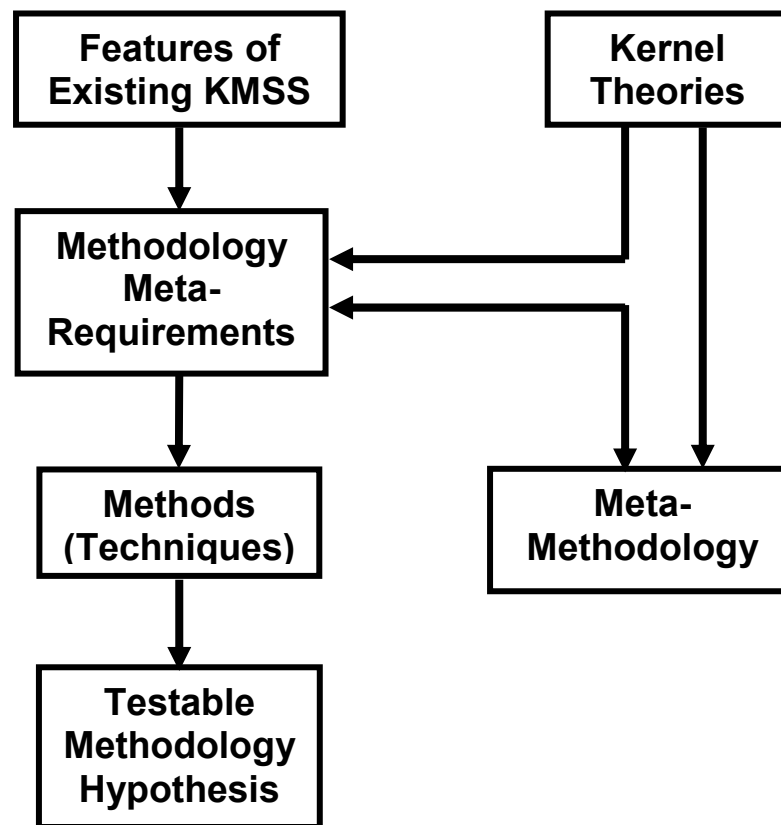


Figure 1. The relationship among the constituents of “Methodology Design Theory (MDT).

3. THE DISTINCTIVE FEATURES OF KNOWLEDGE AND KNOWLEDGE MANAGEMENT SUPPORT SYSTEMS

In order to construct a development methodology for KMSSs, the work to be supported by them has first to be described. This work can generally be described in terms of the characteristics of three elements: *organizational knowledge*, *the knowledge (K-) manipulating processes to be supported*, and *users and their work context* (Markus et al., 2002). The first element, *organizational knowledge*, has the following distinctive features:

- *Action-orientation*: According to Collins (1974), knowledge is a capability and thus creates the capacity to do something. Therefore, organizational knowledge is always anchored to business things toward which thought or action is directed or is communicated by the members of the firm (Hislop et al., 2000) and is constantly produced and re-produced through its business application (Augier & Vendela, 1999) in order to create business value. One of the implications of the action-orientedness is its *indeterminacy*: As the business environment is in the state of continuous change and as organizational knowledge whatever its type is engrained in business activities, it is difficult to determine a-priori what knowledge will be requested, who will request it, who will supply it, and when and how the knowledge will be used (Abou-Zeid, 2002; Markus et al., 2002).
- *Distributedness*: Organizational knowledge is spatially and temporally distributed as it is generated, owned and used by *autonomous* members of the organization, e.g., individuals and groups, and mobilized among them (Boland et al., 1996; Bonifacio et al., 2002). Moreover, the actions of organization members and their interpretation of symbolic representation of knowledge (explicit knowledge or information) are grounded in their *collective* tacit knowledge

which has been formed in the course of past socialization and has become basic assumptions (Tsoukas, 1996; Polanyi, 1983).

- *Situatedness*: Knowledge cannot be disembodied from the people who carry it or from the situations in which they engage (Sierhuis & Clancey, 1997). Therefore, using knowledge depends on the situation and people involved rather than on absolute truth or hard facts. Even the effective re-use of knowledge representations requires its re-creation to suit the local conditions (Collins, 1993; von Krogh et al., 2000; Boland & Tenkasi, 1995).

The aforementioned distinctive features of organizational knowledge require that *K-manipulating processes*, the second element, to be *social* and *contingent*. First, since organizational knowledge is distributed and context-dependent, most K-manipulating processes involve social interactions among organization members. Moreover, knowing and learning are inherently situated and distributed phenomena, residing in a series of non-localizable associations between social and material elements (Nidumolu et al., 2001; Araujo, 1998). Second, as organizational knowledge is action-oriented and situated the type of its manipulating processes and the patterns of their execution are contingent upon these factors.

These characteristics of organizational knowledge and its manipulating processes call for re-conceptualizing *users of KMSS*, the third element, as *active social actors*. First, the use of knowledge and the interpretation/re-interpretation of explicit knowledge (or symbolic knowledge representations) cannot be disembodied from the user. Therefore, *the users of KMSS have to be considered as constituents of such systems who play specific roles in their operations*. Second, because of the distributed nature of organizational knowledge and the sociality of its manipulating processes, i.e., involve social interactions among organization members, the concept of the KMSS user is best described as a social actor - defined as “an organizational entity whose interactions are simultaneously enabled and constrained by the socio-technical affiliations and environments of the firm, its members, and its industry” (Lamb & Kling, 2003, p. 218) .

The distinctive features of organizational knowledge and its manipulating processes, together with the concept of active social actor suggest that the dominant capture/codify/store approaches (Hildreth & Kimble, 2002) for developing KMSS are ineffective (Malhotra, 2002; Swan et al., 2000). First, these approaches are based on the conceptualization of an ICT-based system as a representation of another pre-given “real world” system that enables its users, through its processing functions, to obtain information about a certain domain without having to observe it (Wand et al., 1995). Central to this conceptualization is the notion of “representability”, i.e., the capability of representing the knowledge about the pre-given and objective things that exist in the real world using static structures such as entities and objects. Underlying this notion is the assumption that knowledge exists independently of human knowers (Hirschheim et al., 1995) and consequently can be publicly owned by the organization (Wasko, 1999). However, knowledge representations, which are static and context-independent structures, cannot be equated with knowledge, which is dynamic and context dependent (Malhotra, 2002). Second, these approaches treat the user as an atomic individual capable of articulating her/his knowledge requirements well (Hahn & Subramani, 2000; Lamb & Kling, 2003). Moreover, they consider users as external entities who have no major role in manipulating knowledge, i.e., *disembodiment assumption*.

Such distinctive features of organizational knowledge and KMSS make it difficult for traditional systems development methodologies to be directly applicable. Hahn and Subramani (Hahn & Subramani, 2000) identified four major differences between KMSS and traditional IS. First is the

difficulty to define in advance the profile of a typical user. Second, in the knowledge management context, the final outcome of development efforts needs to be flexible. Third is inappropriateness of final product-oriented approach. Fourth is the importance of user motivation (involvement). The fifth major difference, which is identified by Wasko (1999), is about ownership. Traditional IS applications are used to handle information typically considered to be owned by the organization while the main concern of KMSSs is knowledge owned by individuals.

4. AUTOPOIESIS AS A KERNEL THEORY FOR KMSS DEVELOPMENT METHODOLOGY

The search for kernel theories requires a closer look at the system theories that go beyond the traditional system theory that is based, among other things, on Cartesian dualism, i.e., mind/body or cognition/action, and on a model of cognition as the processing of representational information (Mingers, 2001). One of the candidate theories is the theory of autopoiesis, which can be best viewed as a system-grounded way of thinking with biological foundations, together with its extension into social domain.

In order to conceive of living systems in terms of the processes that realized them, rather in terms of their relationships with an environment, Maturana and Varela (Maturana & Varela, 1980) coined the word *autopoiesis* (αυτοσ = self, ποιενιν = creation, production) to denote the central feature of their organization, which is “autonomy”. The meaning of this word conveys the very nature of living systems as systems that maintain their *identity* through their own operations of continuous self-renewal. Moreover, these systems could only be characterized with *reference to themselves* and whatever takes place in them, takes place as necessarily and constitutively determined in relation to themselves, i.e., *self-referentiality*.

One of the key concepts of autopoiesis is the distinction between *organization* and *structure*. On one hand, *organization* is the capability of a system to re-produce its identity by referring constantly to itself, through the alternate re-production of its components together with the component-producing processes, i.e., the capability of a recursive self-reproduction. On the other hand, *structure* is the realization of a system's organization through the presence and interplay of its components in a specific realization space. While *organization* is necessary to establish system unity and identity, *structure* is necessary because different spaces of its actualization impose different constraints on system's components (Maturana & Varela, 1980). By rough analogy, an algorithm for solving certain problem can be viewed as a description of the system's organization whereas the corresponding computer program can be viewed as the realization of this organization (structure) in a certain space (programming language).

4.1. Autopoietic Systems

An autopoietic system is defined by Maturana and Varela as “a network of processes of production, transformation and destruction of components. These components constitute the system as a distinct unity in the space of its actualization and they continuously regenerate and realize, through their interactions and transformations, the network of processes that produce them.” (Maturana & Varela, 1980, p.135)

Among the distinct characteristics of the autopoietic systems, the most relevant ones are:

- **The simultaneous openness and closure.** Autopoietic systems are *open* with respect to structural interaction with the environment, i.e. *structural openness*, which is unavoidable consequence of the fact that system elements must satisfy the particular requirements of the physical domain in which they occur, while they are *closed* with respect to their own organization, i.e. *organizational closure*. The recognition of *the simultaneous openness and closure* of autopoietic systems is in opposition to the tradition for which a system is one or the other but not both. This interpretation is possible only because of the clear distinction between organization and structure (Bednarz, 1988).
- **Structural determination.** The state transition a system undergoes in response to environmental perturbations is entirely determined by its structure at that time. Moreover, a system specifies which environmental perturbations may trigger which structural changes. In other words, the environmental perturbations could trigger the system's structural changes but can never determine or direct these changes. Moreover, a system specifies which environmental perturbations may trigger which structural changes. Over time, through ongoing interactions with the environment, an autopoietic system will experience what Maturana and Varela (Maturana & Varela, 1992) describe as a *structural drift*, or a gradual change to their structure. The nature of this change is determined by previous system's history of structural changes, i.e., its *ontogeny*.

4.2. Higher-order Autopoietic Systems

Two (or more) lower-order autopoietic systems can be “structurally coupled” to form higher-order autopoietic system. *Structural coupling* is the ongoing process of the congruent structural changes between two (or more) systems that results from recurrent interactions between (among) them. Therefore, structural coupling has connotations of coordination and co-evolution. Moreover, following structural determination principle, two structurally coupled systems means that each of them selects from its possible structural changes those which are compatible with those in the other system and, at the same time, are suitable for the maintenance of its identity.

Social systems, such as enterprises, are constituted through the process of third-order structural coupling, or *social coupling*, the one that occurs between (or among) two (or more) second-order autopoietic systems. However, the unique feature of any human social system, such as an enterprise, is that the social coupling among its constituents occurs through “*language in the network of conservations which language generates and which, through their closure, constitute the unity of a particular human society*” (Maturana & Varela, 1992, p. 196). From this perspective, language is viewed as an example of social structural coupling that generates the self and creates *meaning* through interactions with others. Moreover, language represents what Maturana and Varela would describe as a *consensual domain*, which is defined as “the domain of interlocked conducts that results from ontogenetic structural coupling between structurally plastic organisms” (Mingers, 1995, p. 78). Within a consensual domain, two autopoietic systems would be able to observe the attribution of meaning to common events and undertake coordinated actions.

4.3. The Autopoietic Perspective of Organizational Knowledge

Cognition is the term conventionally used to denote the process by which a system discriminates among differences in its environment and potential states of that environment. The evidence for this cognition is effectiveness of system behavior in response to the environmental perturbations. The underlying premise of the dominant perspective on cognition, and consequently IS, is the idea that

effective action is explainable in terms of manipulating formal and static representations of the objective reality (Mingers, 2001).

In contrast, according to theory of autopoiesis, perception is neither objectivist nor purely constructivist (Varela, 1992, p. 254). Rather, it is co-determined by the linking of the structure of the perceiver and the local situations in which it has to act to maintain its identity. This is the basis of *enactive (embodied) cognition* which implies that the autopoietic system's activities condition *what can be perceived* in an environment, and these perceptions, in turn, condition future actions. In this view, "A cognitive system is a system whose organization defines a domain of interactions in which it can act with relevance to the maintenance of itself, and the process of cognition is the actual (inductive) acting or behaving in this domain." (Maturana & Varela, 1980, p. 13). Therefore, cognition, according to autopoietic theory, is essentially embodied. Or, in Maturana and Varela words, "All doing is knowing, and all knowing is doing" (Maturana & Varela, 1992, p. 26). In addition, cognitive domain of an autopoietic system is defined as the domain of all the interactions in which it can enter without loss of identity (Maturana & Varela, 1980, p. 119). Therefore, knowledge is not an object that may be captured, packaged, processed and distributed. Rather, it is an embodied notion. Moreover, the concepts of structural coupling and consensual domains provide the bridge between the cognition of the individual and the patterned behaviors that are often described as 'organizational knowledge' (Kay & Cezec-Kecmanovic, 2005).

As discussed in section (4.2) language is viewed as an example of social structural coupling that generates the self and creates *meaning* through interactions with others. According to theory of autopoiesis "it is by languaging that the act of knowing, in the behavioral coordination which is language, [which] brings forth a world" (Maturana & Varela, 1992, p. 234). In other words, meaning arises as pattern of relationships among the linguistic distinctions done by firm's members through the process of languaging.

5. IMPLICATIONS OF THEORY OF AUTOPOIESIS FOR KMSS DEVELOPMENT METHODOLOGY

One of the implications of theory of autopoiesis is that organizational knowledge is an embodied (enactive) notion and it cannot be treated as an object. Furthermore, it indicates the crucial role played by languaging in creating and sharing new knowledge. This perspective implies that KMSS can be best conceptualized as "an additional medium through which interlocking behaviors may converge and the congruities of context, that give rise to consensual domains" (Kay & Cezec-Kecmanovic, 2005).

From autopoietic view introducing a new KMSS in an enterprise can be conceptualized as a kind of perturbation that provokes or triggers enterprise's structural-determined responses. Therefore, KMSS development process can be viewed as the means for realizing structural coupling between an enterprise and its new KMSS and becomes an integrated aspect of the recurrent interactions between developers and users in the work environment. Table (1) summarizes the implications of theory of autopoiesis for KMSS Development Methodology Meta-Requirements

Concepts from theory of autopoiesis	Implications for KMSS Development Methodology
Organizational Closure and Self-Referentiality	Insider frame of reference. The organizational closure and self-referentiality of an enterprise suggest it is best understood from <i>inside</i> . Therefore, an interpretive or hermeneutic approach could more reliably and intelligibly account for the experiences, intentions and interpretations

	<p>of its members. Moreover, the main role of system developer is the role of “<i>catalyst</i> and/or <i>emancipator</i>” (Hirschheim & Klein, 1989) who helps enterprise’s members to develop the necessary inquiring, collaborative and communicative patterns needed to continuously explicate their information requirements.</p>
Structural Determination and Structural Coupling	<p>Historicity. As an enterprise is continuously reproducing itself, it must do so with constant reference to itself, its past practices, values, decisions, contracts, and commitments (Truex et al., 1999). Therefore, explicating enterprise’s history is an essential element in developing new knowledge and in introducing a new KMSS (von Krogh et al., 1994).</p> <p>Context-dependency of KMSS development methodology. Viewing KMSS development methodology as the means for realizing structural coupling between an enterprise and its new KMSS implies that it cannot be separated from enterprise’s context. In other words, autopoietic metaphor of an enterprise and its KMSS suggests “strong” approaches to systems development instead of the commonly used “weak” approaches (Vessey & Glass, 1998).</p>
Embodied Cognition	<p>Minimal set of initial requirements. The autopoietic view of cognition implies that requirements are always in motion, unfrozen, and negotiable (Truex et al., 1999). Therefore, KMSS development can be viewed as open-ended bootstrapping process that starts with a minimal set of requirements.</p>
Languageing	<p>Moreover, formal representation must be subordinated to the fostering of mutual understanding and coordinated action in the development team and between the team’s members and the stakeholders (Kay & Cecez-Kecmanovic, 2002; Beeson, 2001).</p> <p>As organizational languageing plays crucial role in creating new knowledge and sharing existing one and in co-coordinating action, the main focus of KMSS development methodology has to be directed towards studying of the two domains of organizational languageing, namely, writing and conversations (von Krogh & Roos, 1995).</p>

Table 1. *Autopoietic Implications for KMSS Development Methodology Meta-Requirements*

6. CONCLUSIONS

A design theory for constructing KMSS development methodology is proposed. The theory is composed of six elements, namely, *methodology meta-requirements*, *methods*, *meta-methodology*, *testable hypotheses*, *existing features of KMSSs*, and *kernel theories*.

The application of the proposed theory is illustrated by considering the theory of autopoiesis, as a system-grounded way of thinking with biological foundations, can be useful as one of the kernel theories for both of “design product” and “design process” aspects of “KMSS Development Methodology Theory”. The theory of autopoiesis is used to derive a set of *methodology meta-requirements* which includes *insider frame of reference*, *historicity*, *context-dependency of KMSS development methodology*, *minimal set of initial requirements* and *organizational languageing as the focal subject of KMSS development*.

In addition, there are several implications for the KMSS development methodology deriving from our theoretical orientation. First, organizational knowledge is an embodied (enactive) notion and it cannot be treated as an object which can be captured, packaged and processed. From this perspective, organizational knowledge is nothing but a “purposeful coordination of action” while what is called explicit knowledge (symbolic knowledge representations or information) is the symbolic description of action (Zeleny, 2005). Second, the conceptualization of KMSS as the medium in which the organizational languaging can be realized is introduced.

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